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May et al.

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(54) **SURGICAL KNOT PUSHER AND METHOD OF USE**

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(60) Provisional application No. 60/269,314, filed on Feb. 16, 2001.

(51) **Int. Cl.**
A61B 17/04 (2006.01)

(52) **U.S. Cl.** **606/148**

(58) **Field of Classification Search** 606/139, 606/148, 144; 289/1.5, 2, 17, 18.1
See application file for complete search history.

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Primary Examiner — Gary Jackson
Assistant Examiner — Erin Colello

(57) **ABSTRACT**

A surgical knot pusher device allows a prepared knot to be pushed down a length of suture without deforming or collapsing the knot. The surgical knot pusher device includes a handle portion and an elongate body extending from the handle portion. The elongate body has a curved tip that is tapered and has a groove along a length of the tip. The tip also includes a central channel extending from the groove to a distal end of the tip.

13 Claims, 11 Drawing Sheets

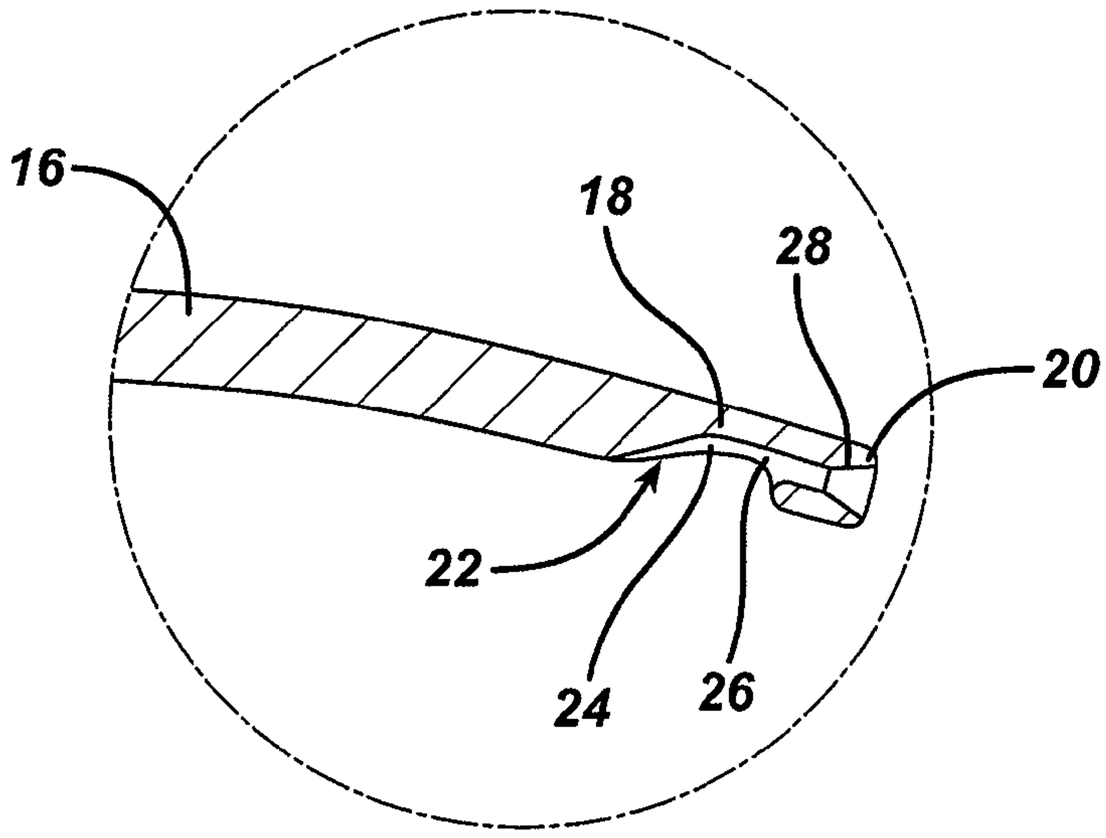

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FIG. 1

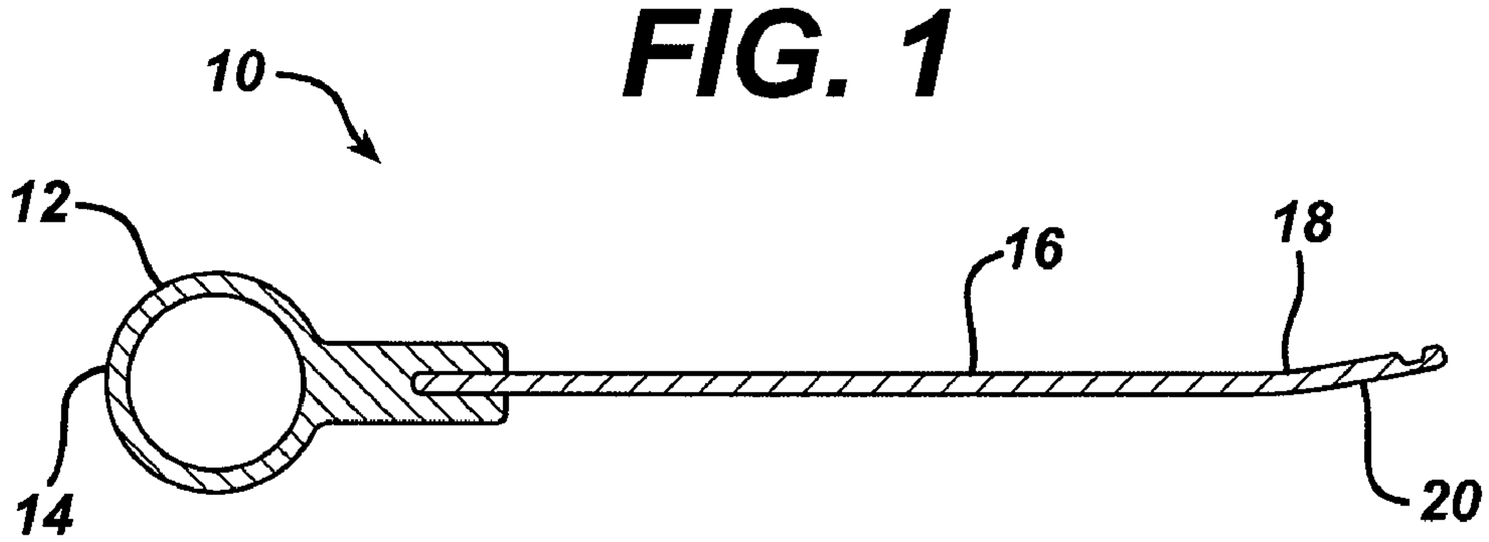


FIG. 2

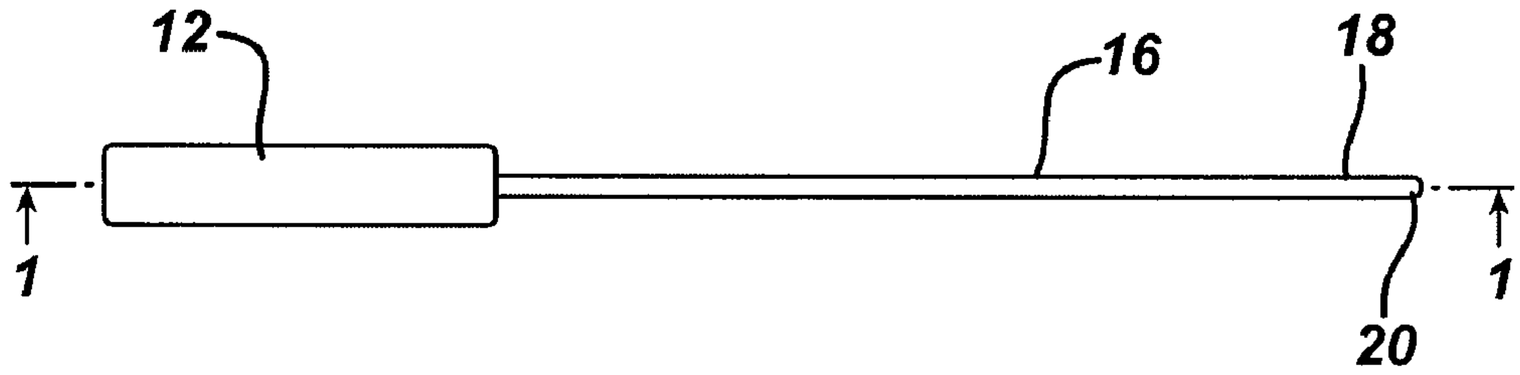


FIG. 3

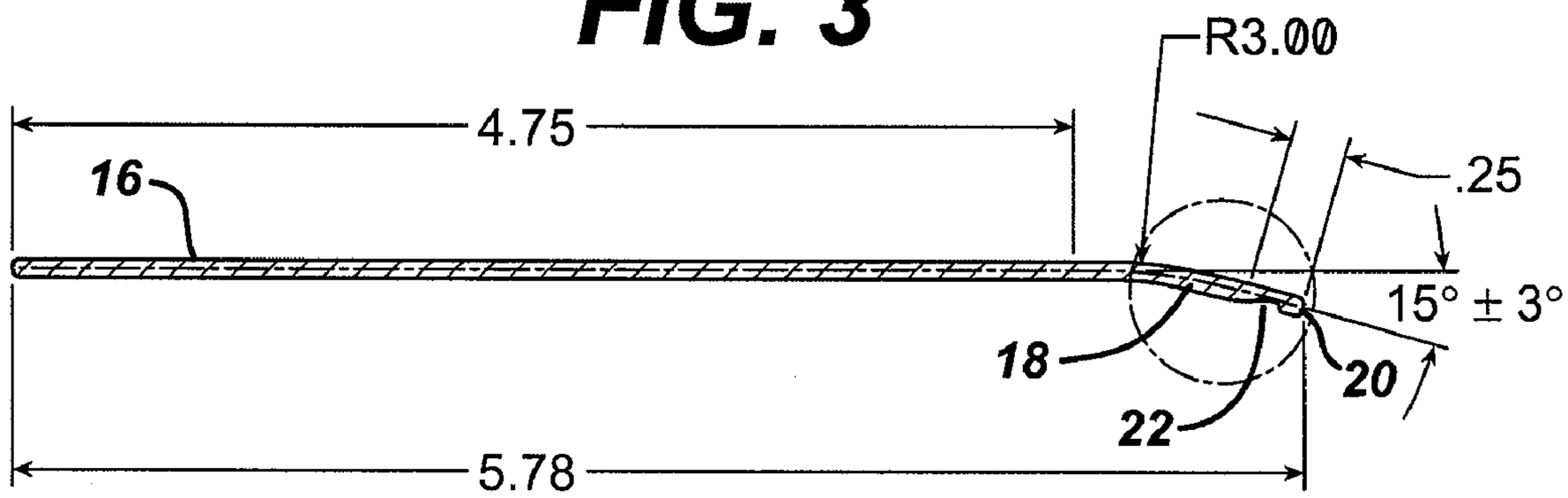


FIG. 3A

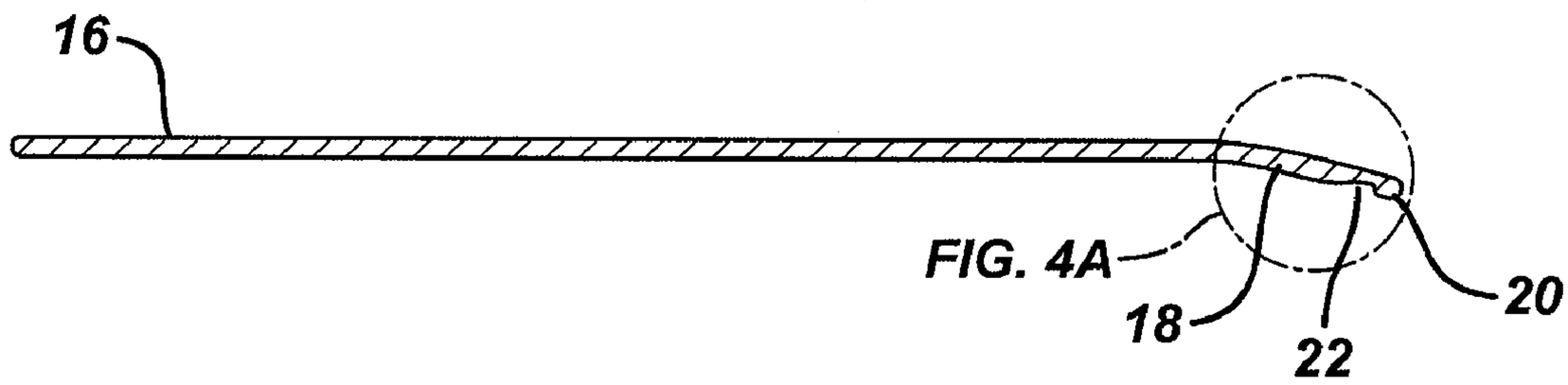


FIG. 4

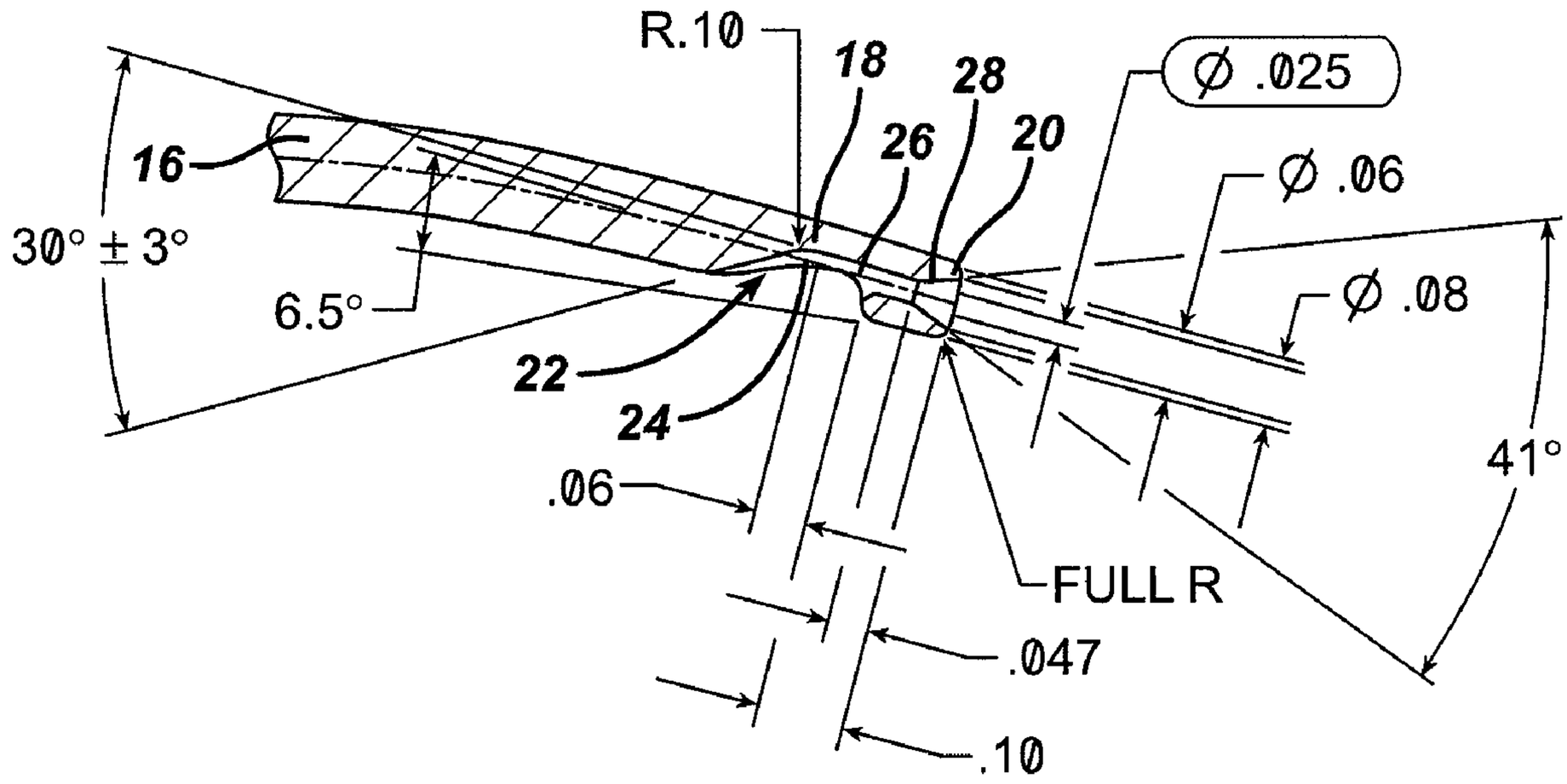
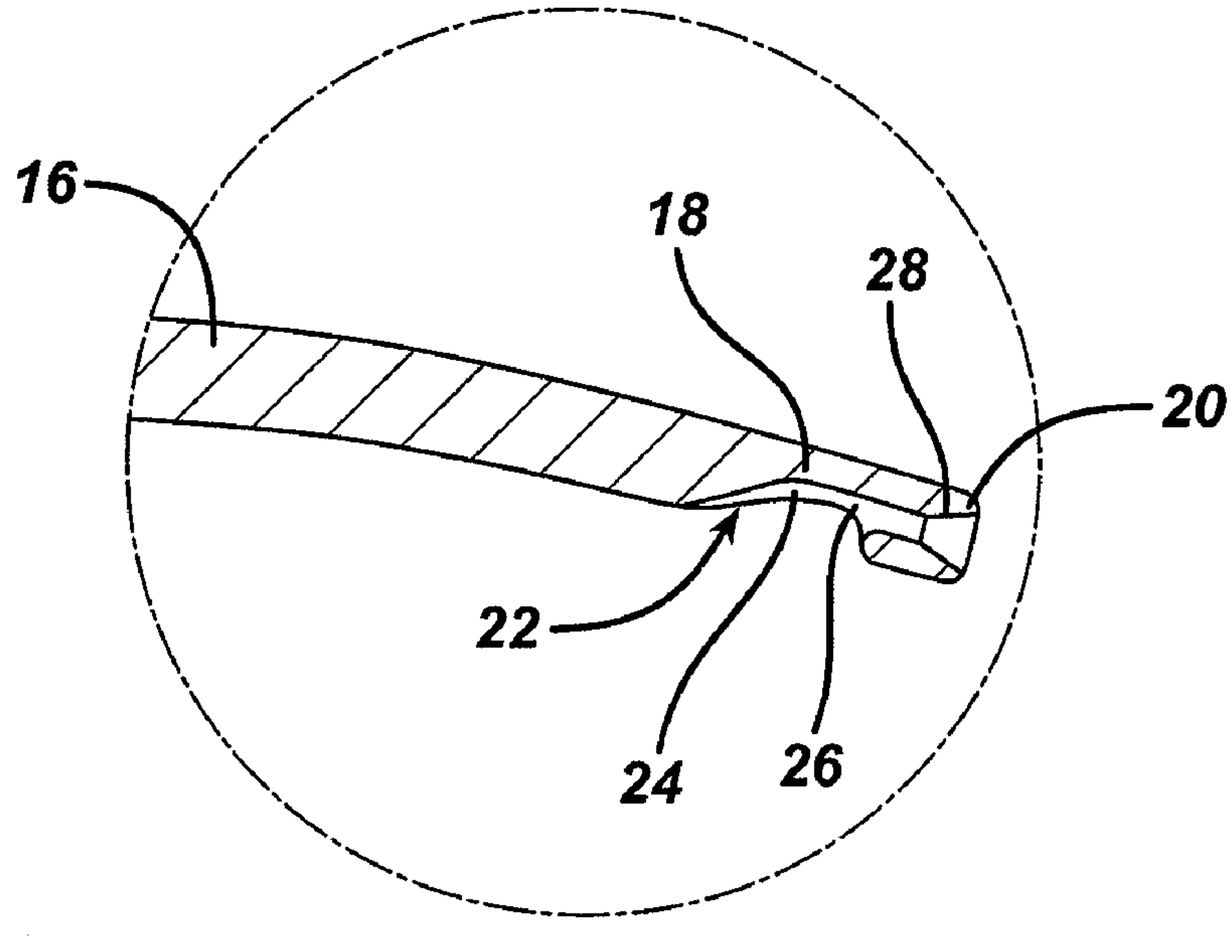

R.10
18
28
26
20
Ø .025
Ø .06
Ø .08
16
30° ± 3°
6.5°
22
24
.06
41°
FULL R
.047
.10

FIG. 4A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18
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22
24
26

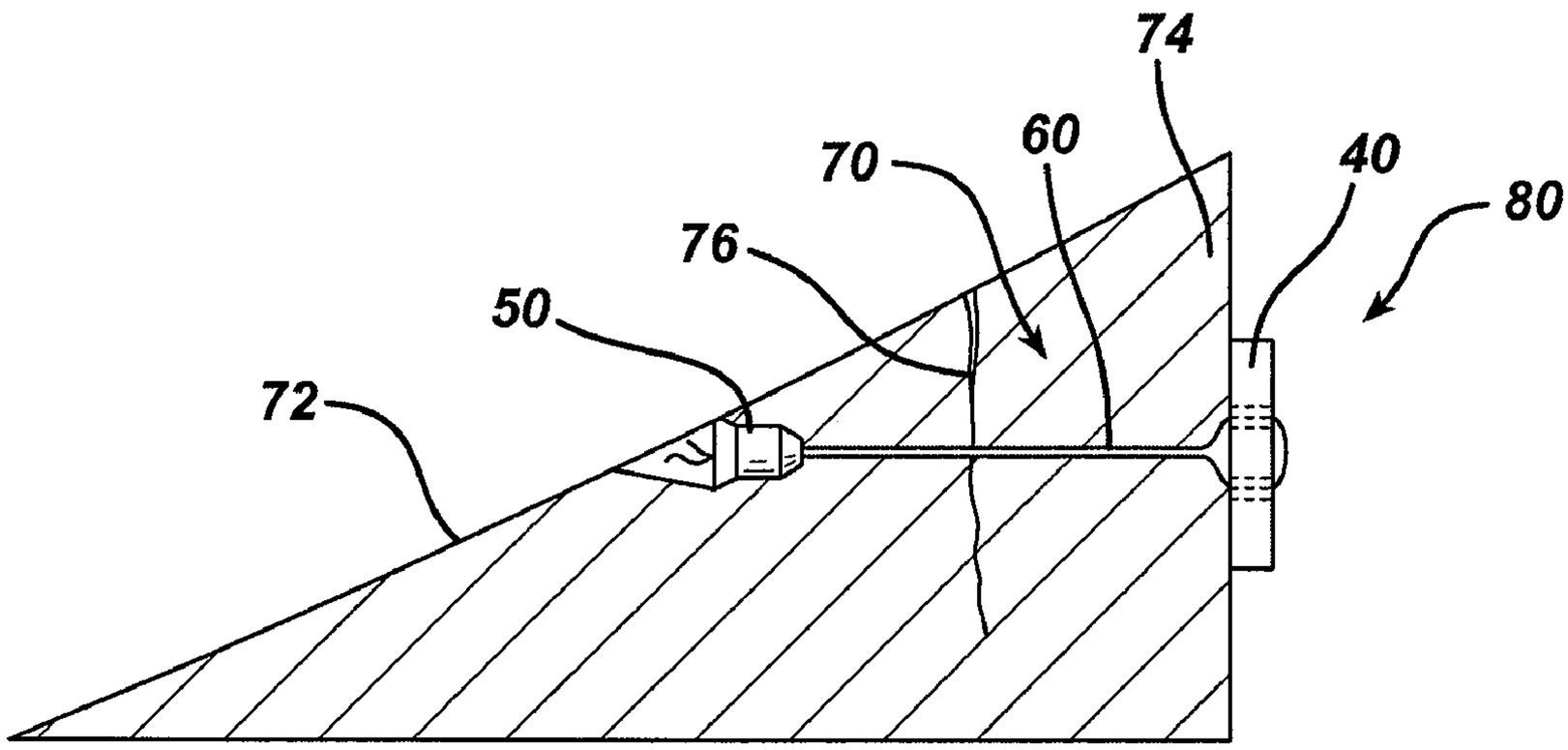


FIG. 5

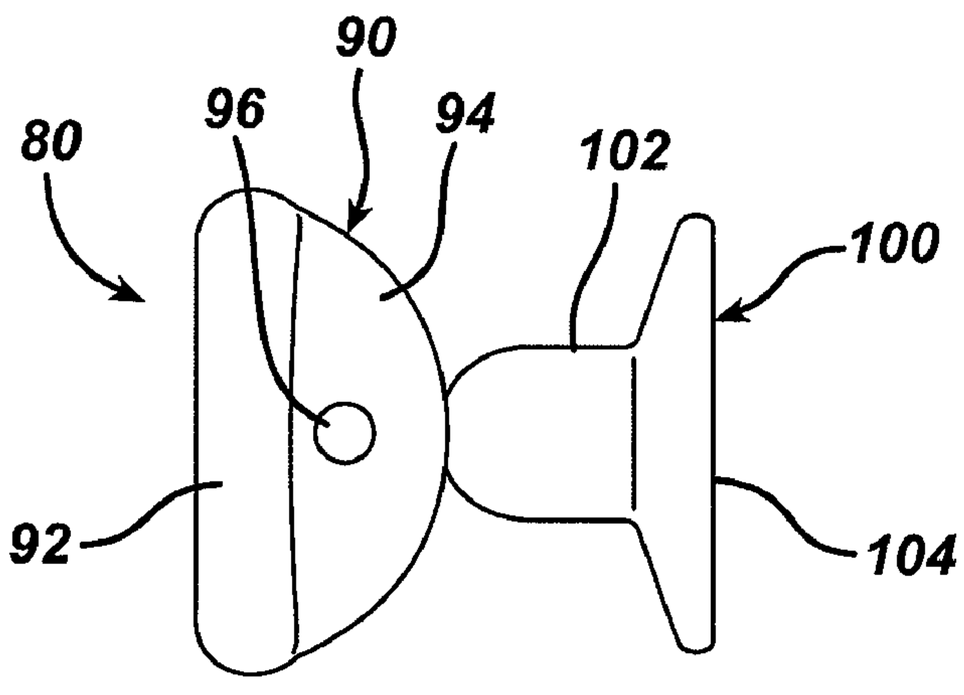


FIG. 6A

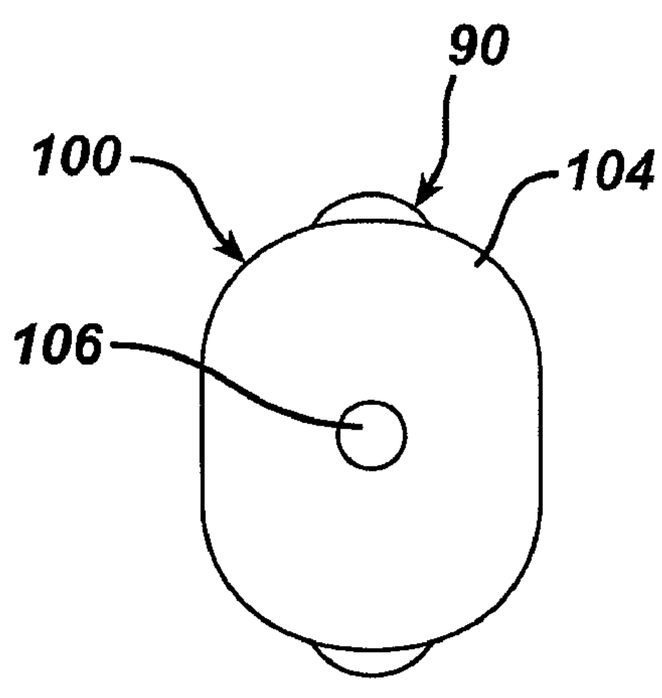


FIG. 6B

FIG. 7

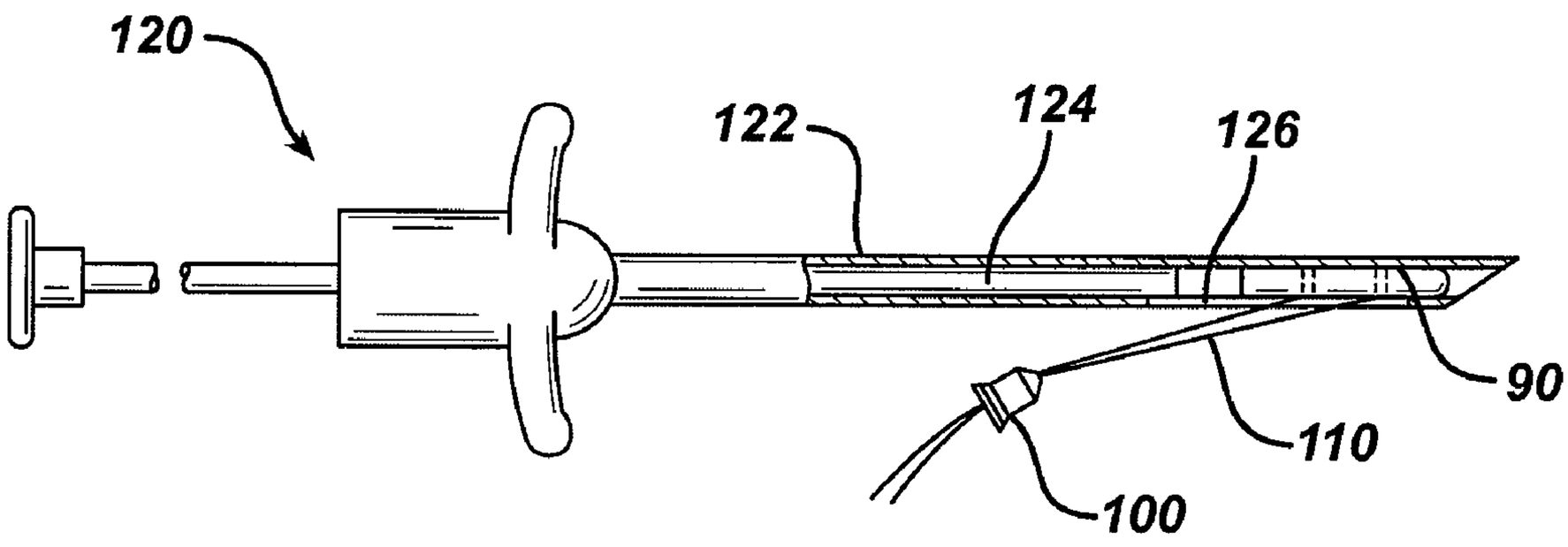


FIG. 8A

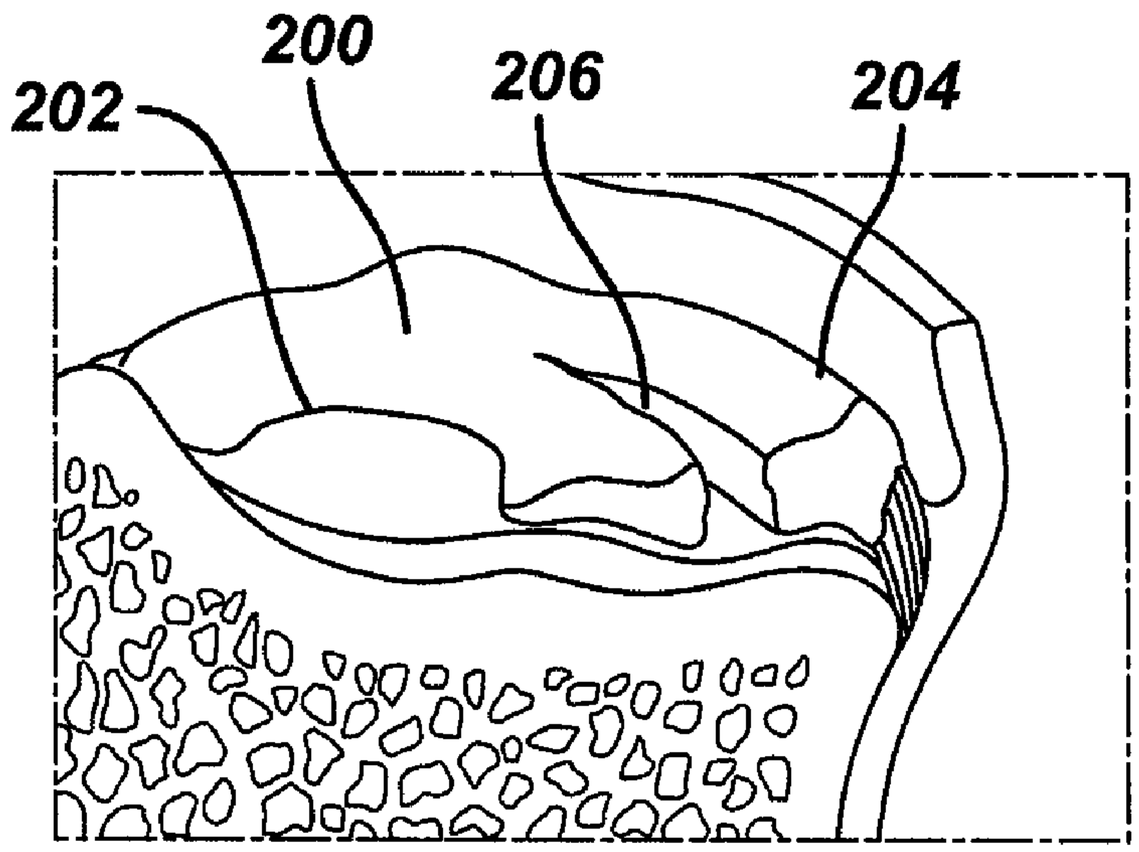


FIG. 8B

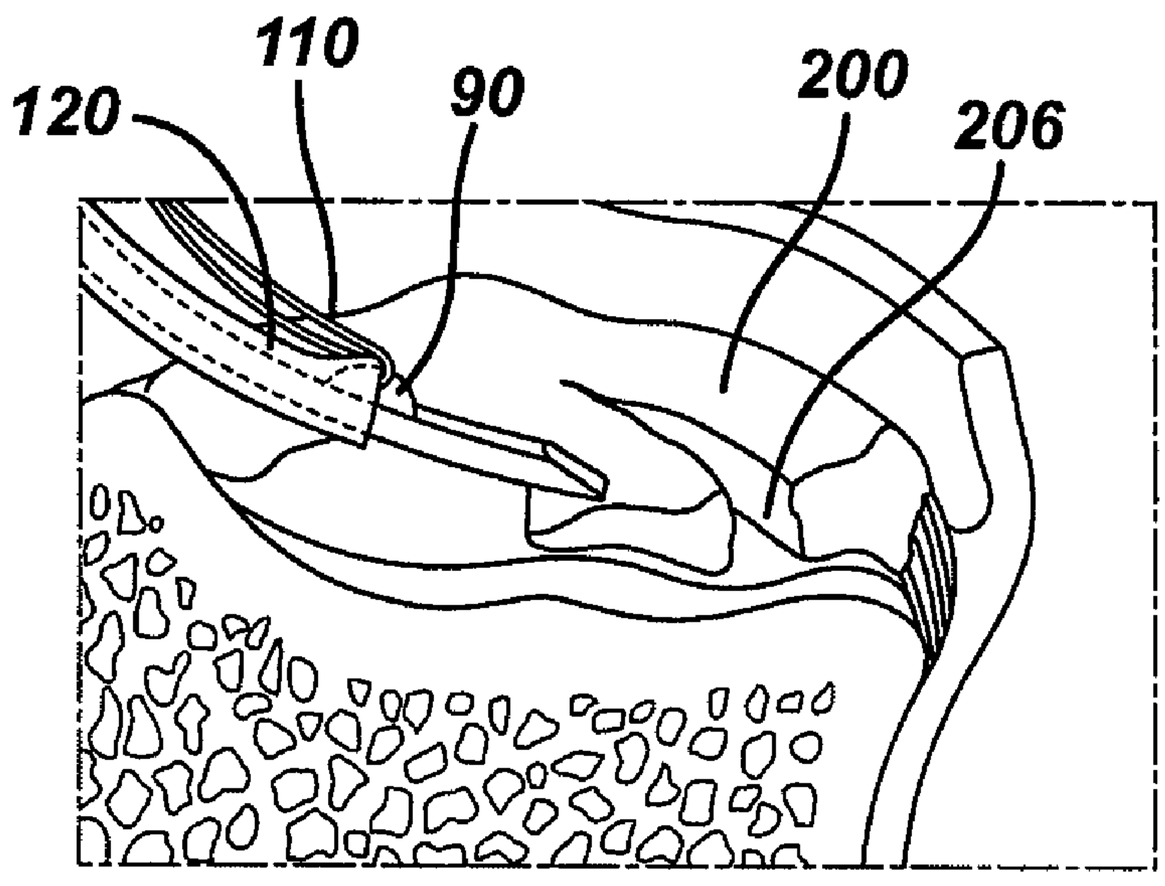


FIG. 8C

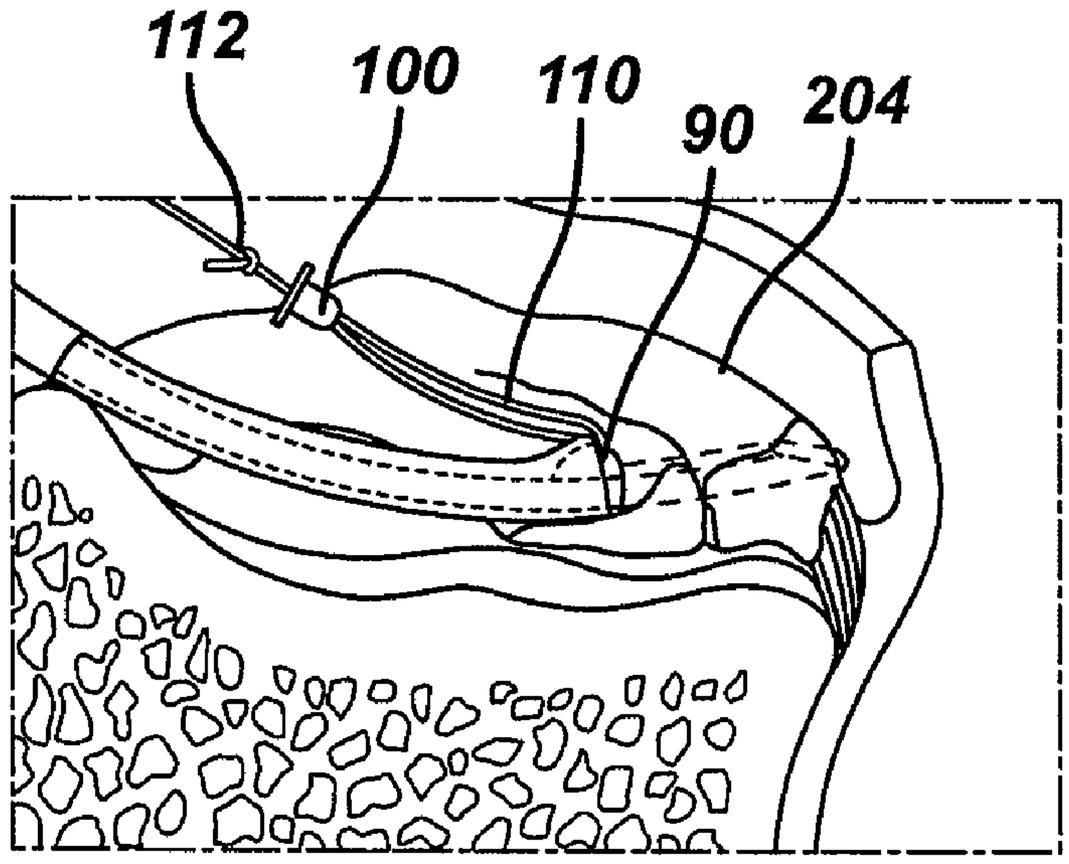


FIG. 8D

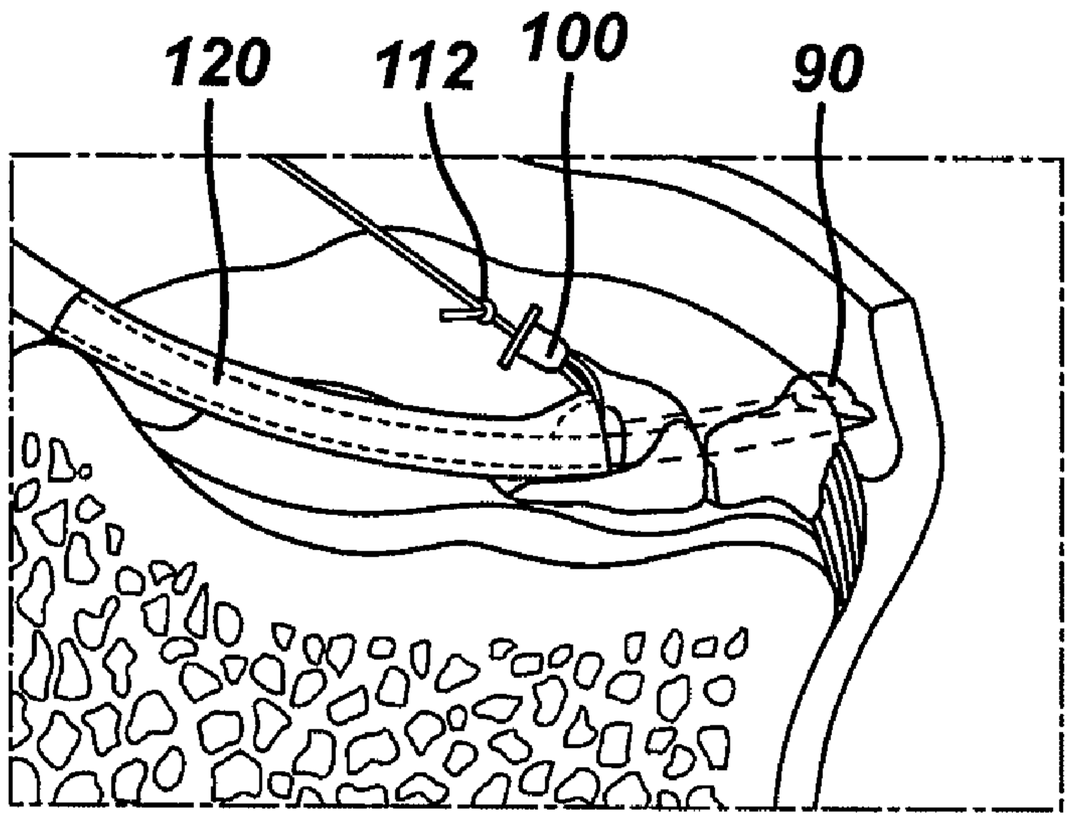


FIG. 8E

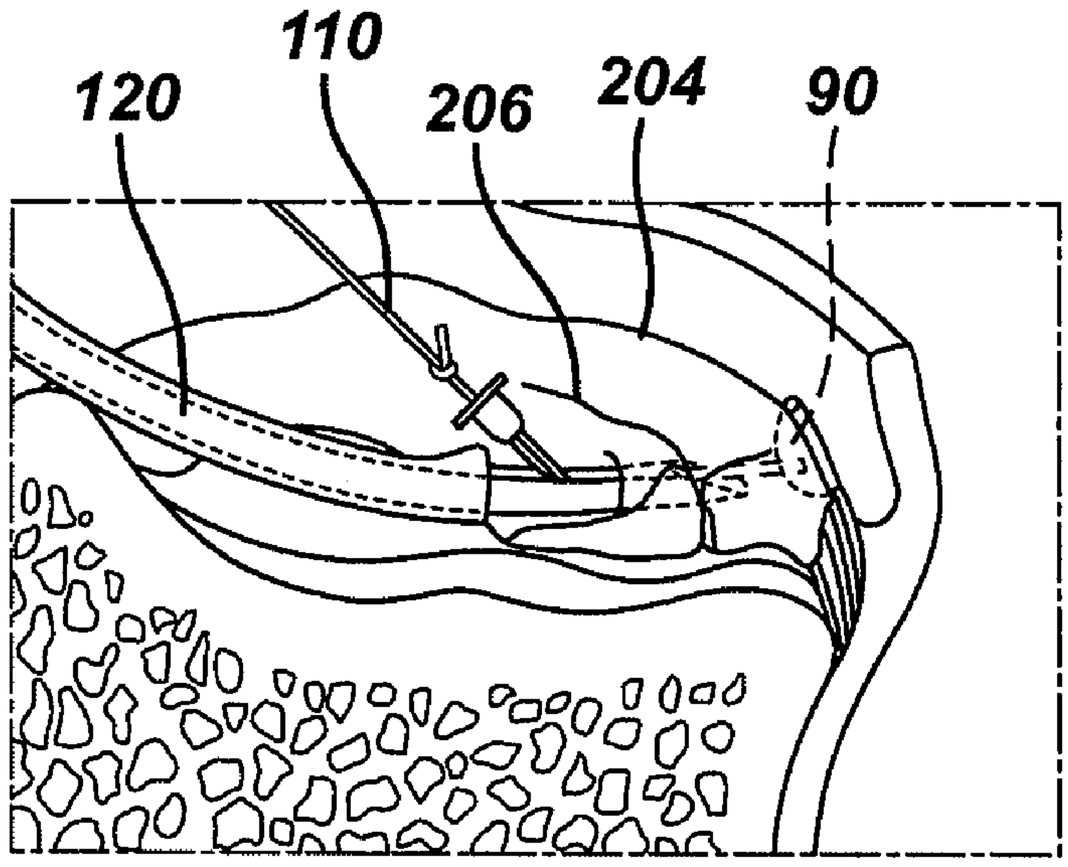


FIG. 8F

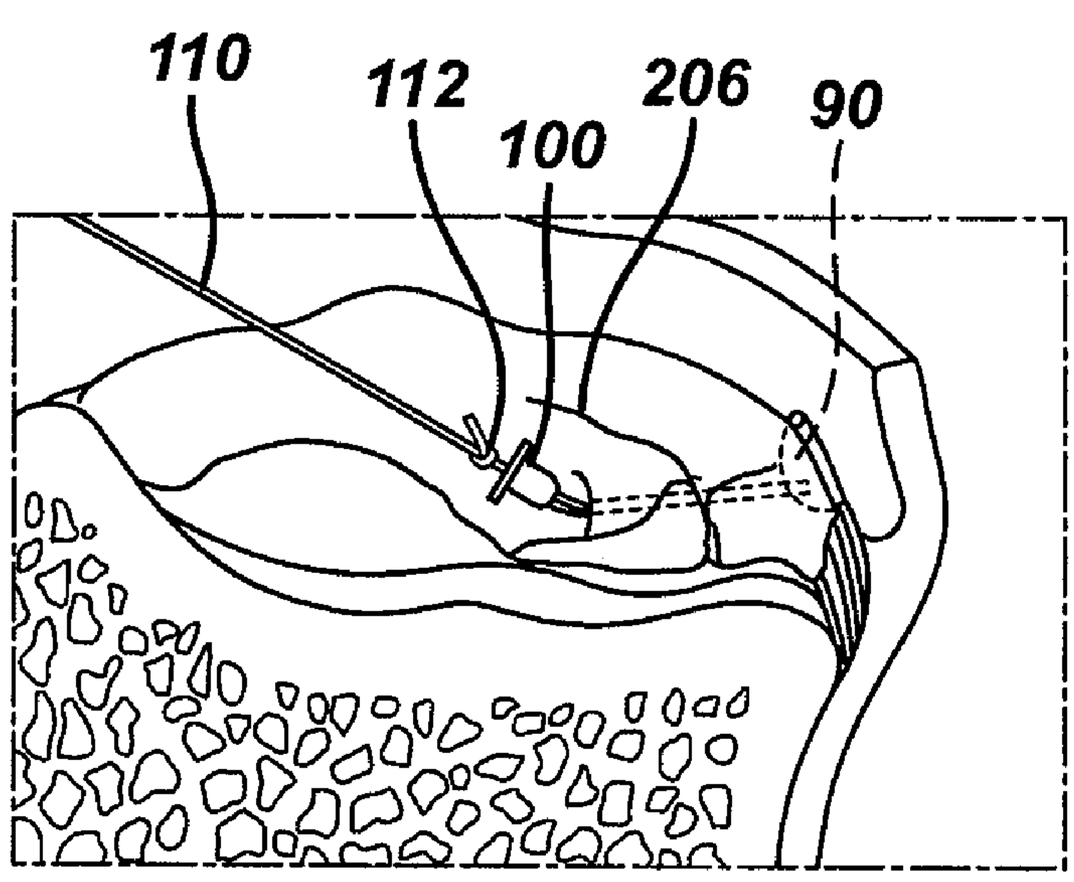


FIG. 8G

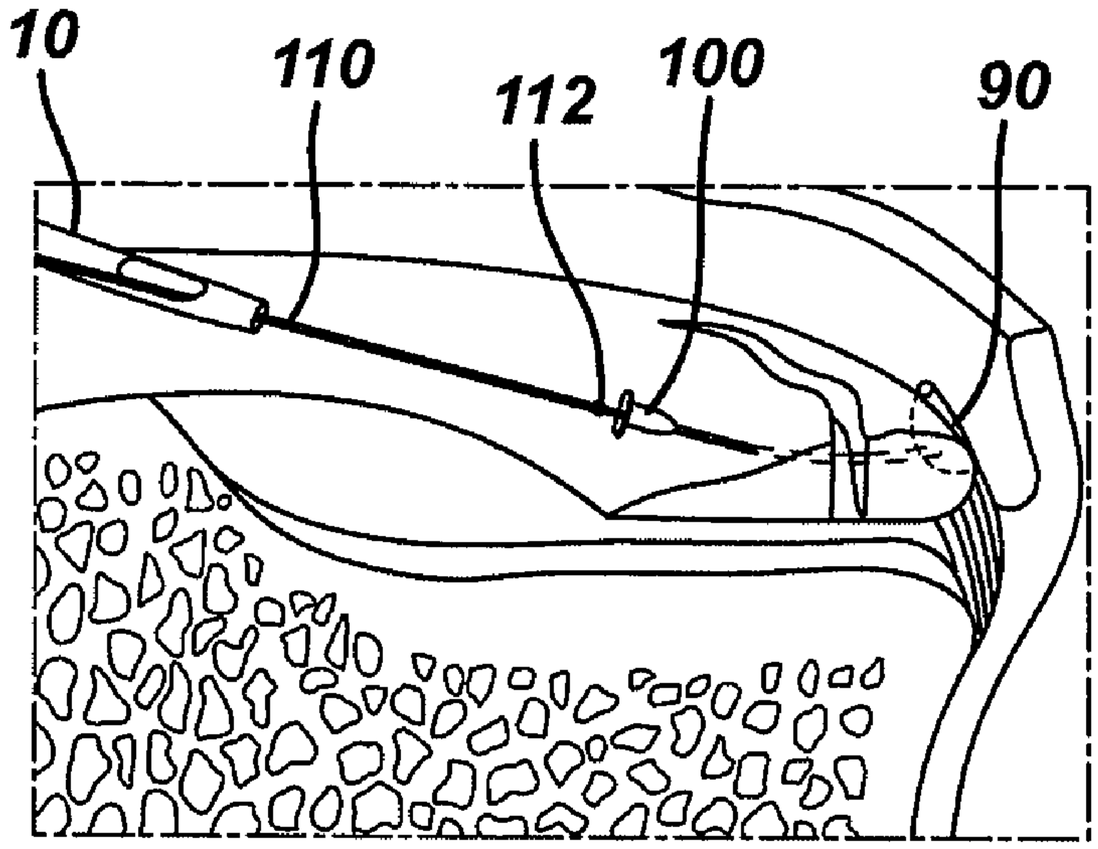


FIG. 8H

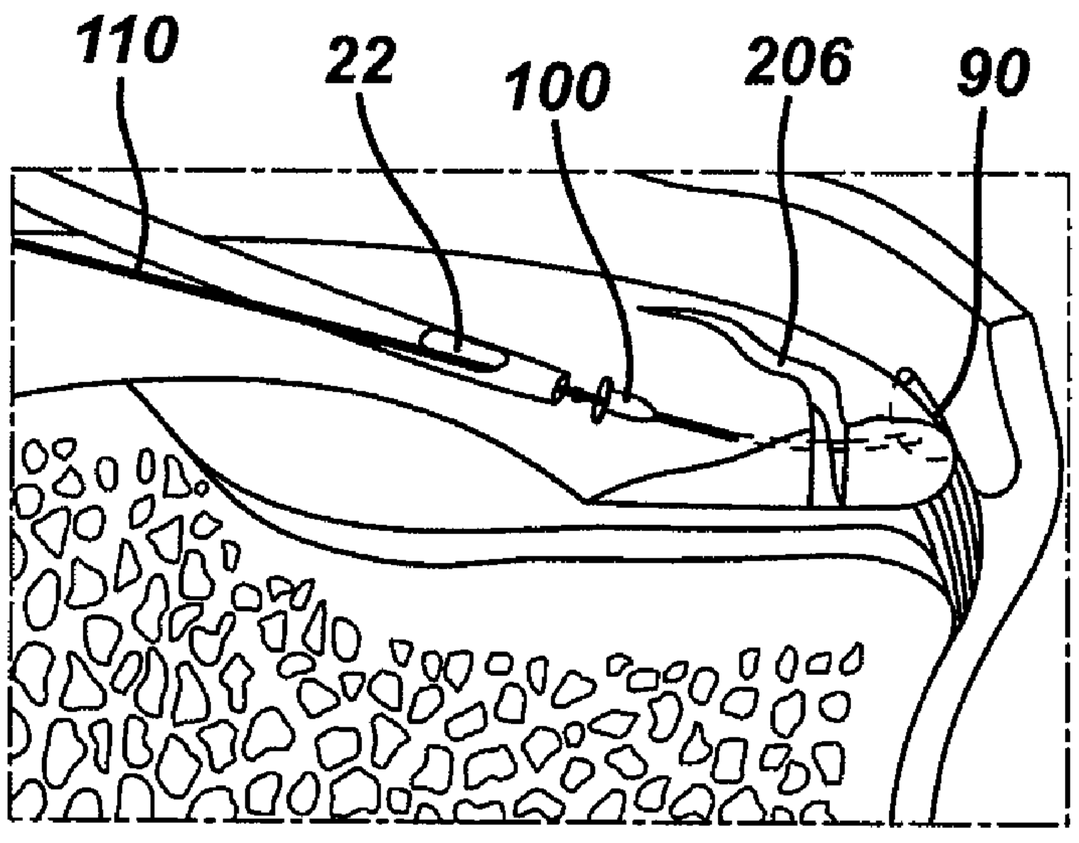


FIG. 8I

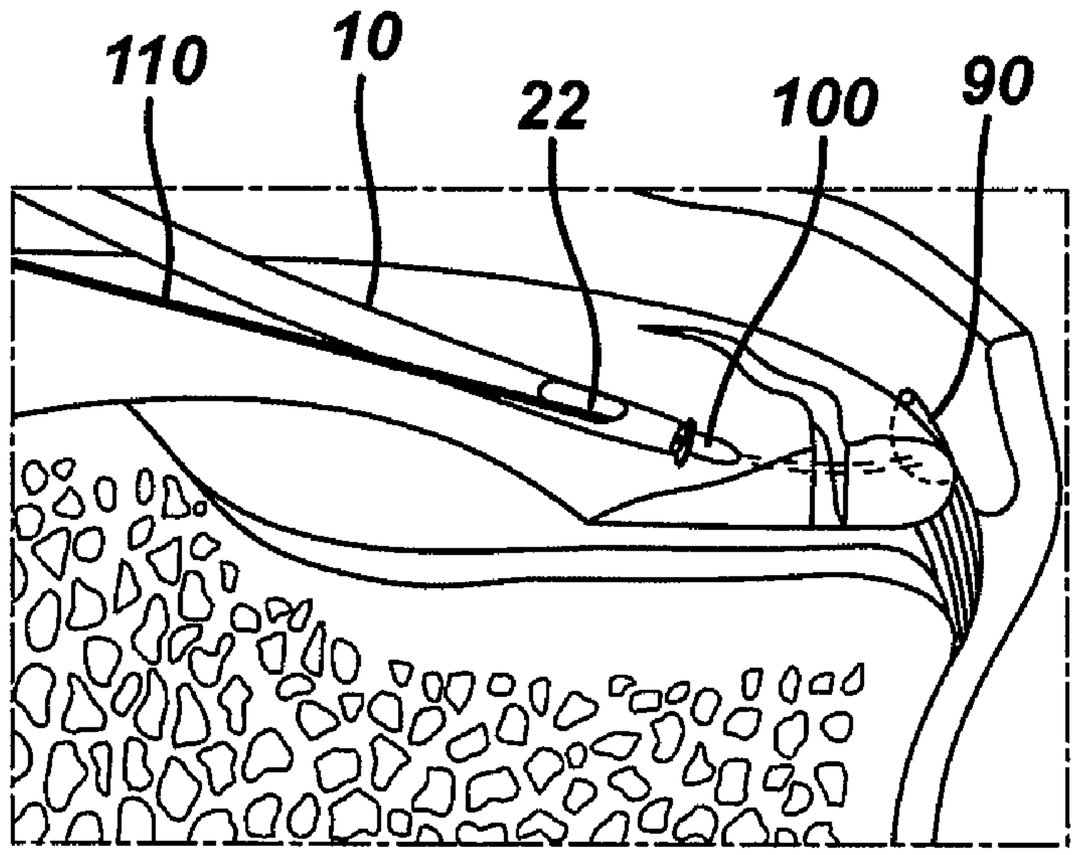


FIG. 8J

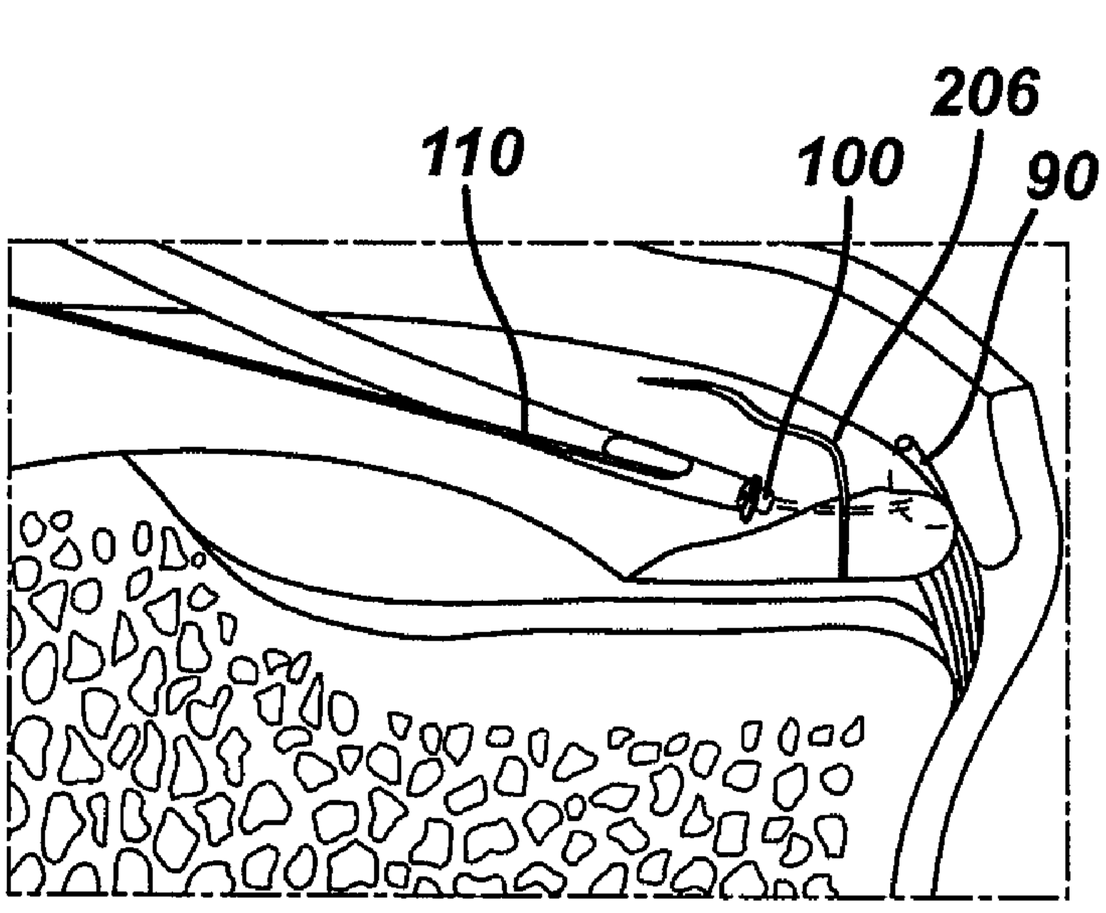


FIG. 8K

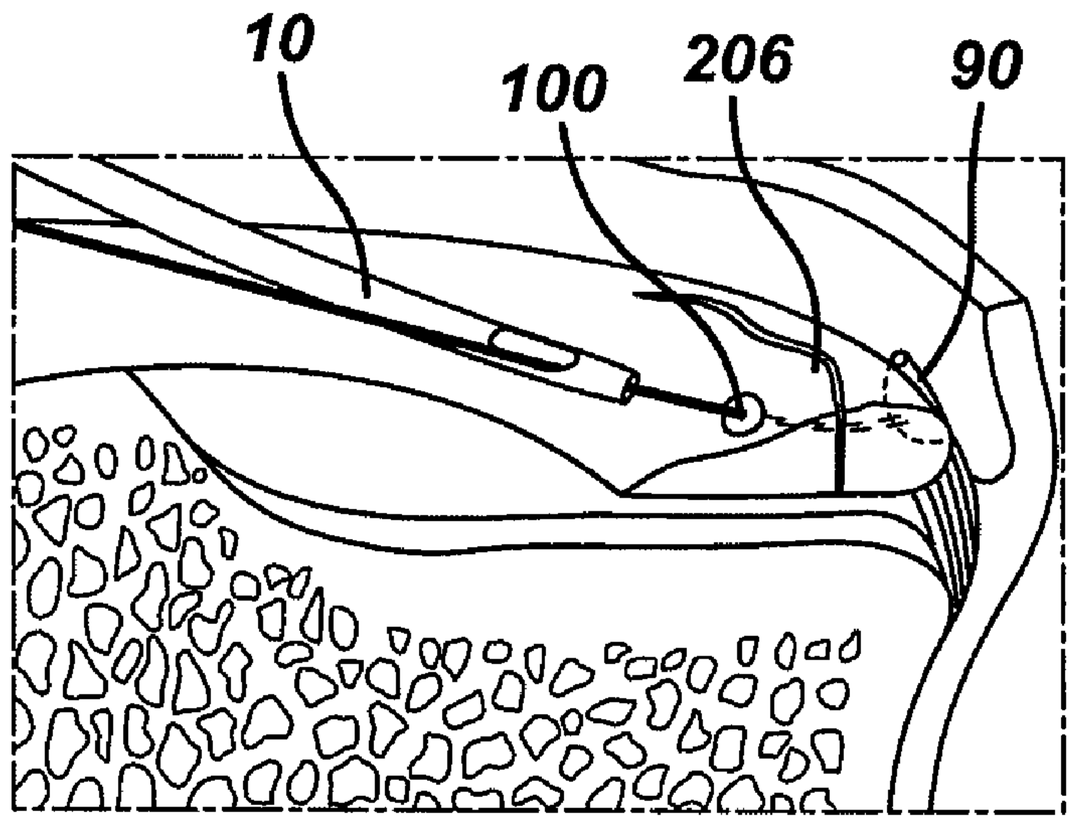


FIG. 8L

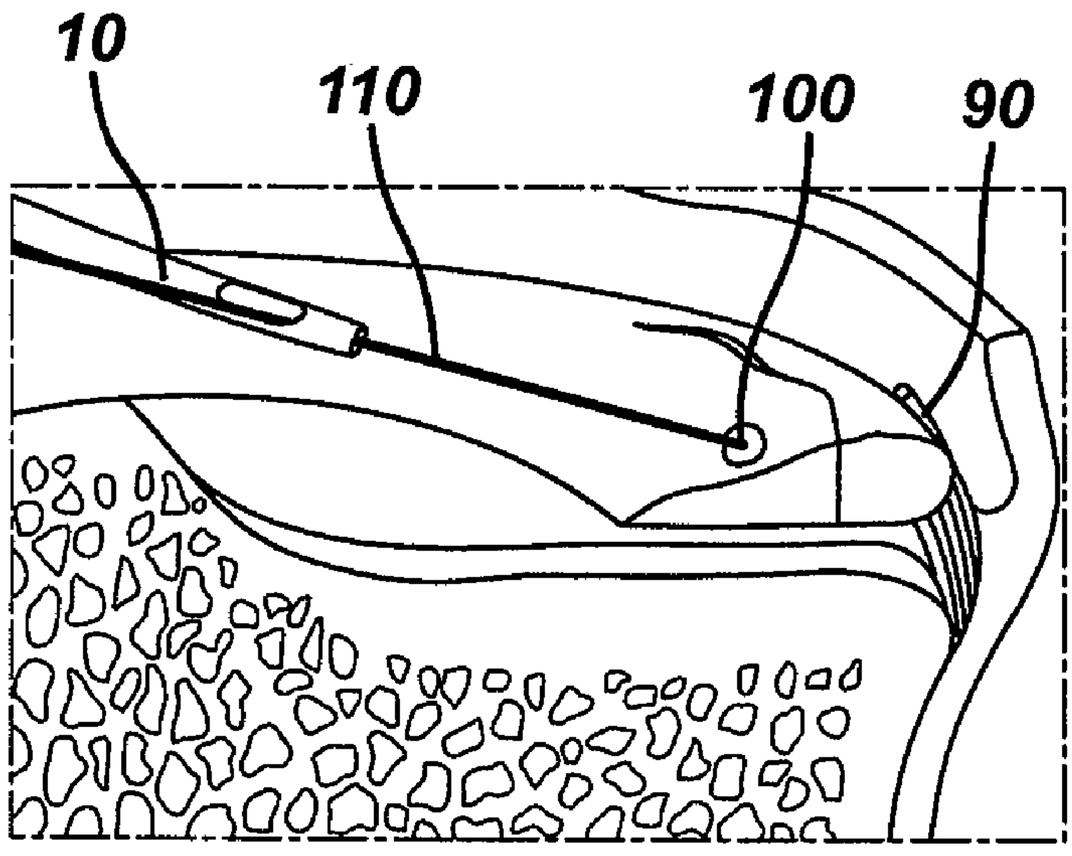
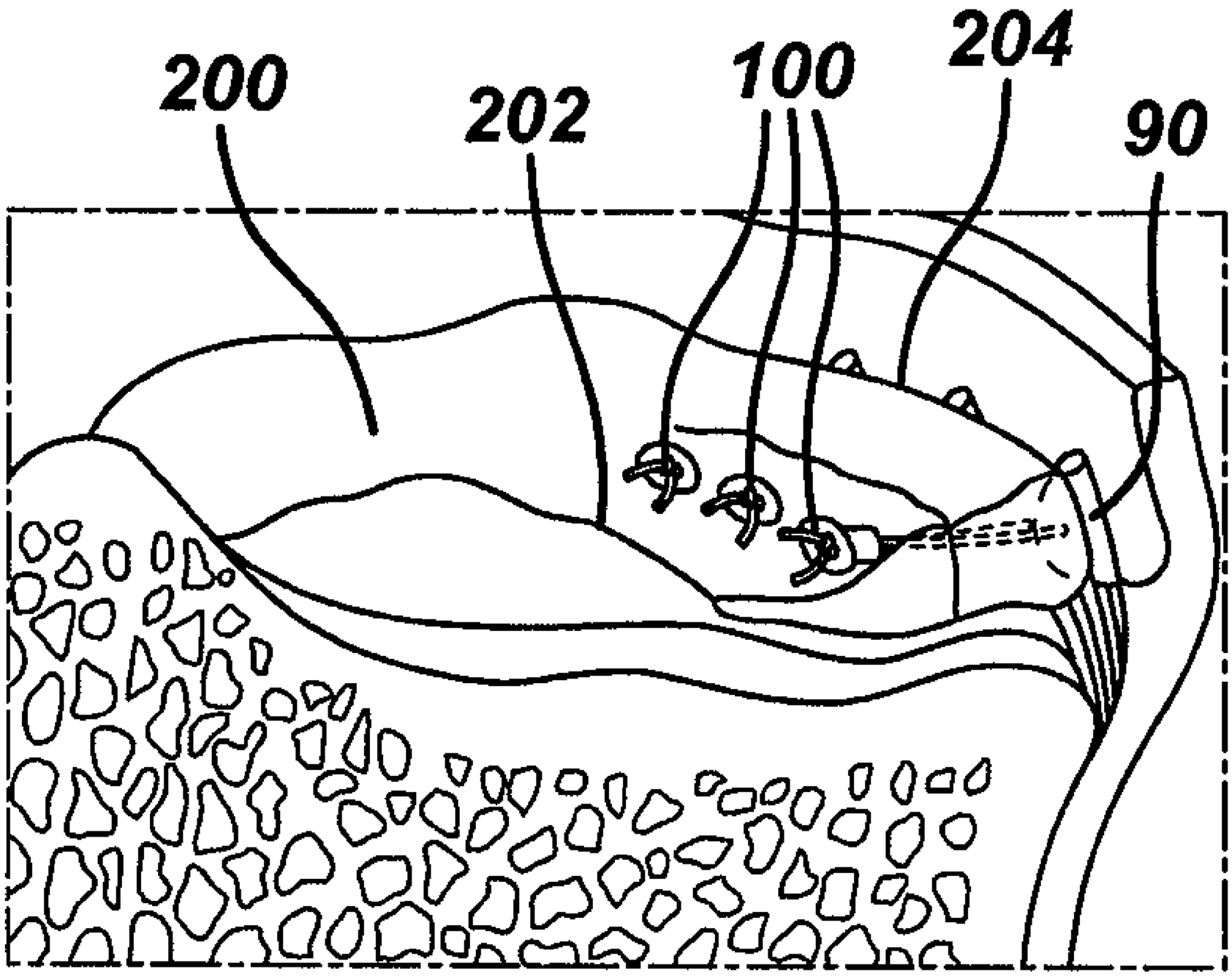


FIG. 8M



SURGICAL KNOT PUSHER AND METHOD OF USE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 10/011,452 filed on Oct. 30, 2001 now U.S. Pat. No. 6,884,249 which is based on U.S. provisional application 60/269,314, filed on Feb. 16, 2001.

FIELD OF THE INVENTION

The invention relates generally to surgical tools for preparing sutures, and to methods pertaining thereto. More particularly, this invention relates to a slip knot pusher for advancing a prepared slip knot down a length of suture without deforming or collapsing the knot.

BACKGROUND OF THE INVENTION

Many surgical procedures require a knot to be tied. For example, to reattach torn tissue, a surgeon will typically form a slip knot around the detached tissue to hold the tissue in place, rather than stitch the torn tissue to the surrounding area. Formation of the slip knot requires the surgeon to manually tie a knot on the ligatures, which are long, relatively straight strands of suture material, after the ligature is threaded through the tissues to be sutured together. This procedure is often tedious and time-consuming. There is also a tendency for the slip knot to deform or collapse as the surgeon manually forces the knot down into its proper position. In addition, tying the knot in this manner is often difficult during endoscopic surgeries such as arthroscopies, where the visual field for the surgeon is severely limited by the narrow surgical area. Because of these setbacks, there exists a need for an improved method of tying a slip knot, and for surgical tools that will facilitate such a goal.

SUMMARY OF THE INVENTION

The present invention overcomes the drawbacks inherent in prior art surgical methods and devices by providing a surgical knot pusher device that allows a prepared slip knot to be pushed down a length of suture without deforming or collapsing the knot. In one embodiment, the pusher includes a handle portion and an elongate body extending from the handle portion. The elongate body has a distal tip at a distal end of the elongate body. A groove is formed in a portion of the distal tip. The tip also includes a central channel extending from the groove to a distal end of the distal tip. The distal tip may be tapered and bent with respect to the elongate body. The distal tip can be bent in a range of angles with respect to the elongate body. Alternatively, the distal tip of the surgical knot pusher device can be straight.

In one embodiment, the pusher is formed from a rigid plastic or metal. However, in another embodiment, the pusher can be formed from a malleable material that enables the surgeon to adjust the angle of the distal tip during surgery.

The surgical knot pusher device of the present invention can be used with a suture locking device for repairing soft tissue defects. The suture locking device can include a wall anchor attached to a tissue implant by a connecting suture having a preformed slip knot. In an exemplary method, the wall anchor is threaded through a soft tissue defect and placed against the outer wall of the tissue surface, with the connecting suture attached to the wall anchor extending across the defect or tear. The tissue implant can be positioned on an opposite wall of the tissue surface. The surgical knot pusher device of the present invention can then be deployed to force the preformed slip knot down the leg of the suture extending from the tissue implant and into the implant itself. The wall anchor acts as a pulley as tension is applied to the connecting suture, effecting closure of the tear and allowing the tissue implant to be pushed into the opposite wall of the tissue surface. An inserter tool comprising a cannulated needle and a push rod can be utilized to introduce the wall anchor and attached suture through the tissue defect.

Further features of the invention, its nature and various advantages will be more apparent from the accompanying drawings and the following detailed description of the drawings and the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of a surgical knot pusher device of the present invention;

FIG. **2** is a sectional view of the surgical knot pusher device of FIG. **1** along lines A-A;

FIG. **3** is a sectional view of a portion of the device of FIG. **2**;

FIG. **3**A is a sectional view of a portion of the device of FIG. **2** with dimension labels removed for clarity.

FIG. **4** is an exploded view of the distal tip of device of FIG. **1**;

FIG. **4**A is an exploded view of the distal tip of the device of FIG. **1** with dimension labels removed for clarity.

FIG. **5** is a perspective view of an exemplary suture locking system deployed across a soft tissue defect;

FIG. **6**A is a side view of another exemplary suture locking system;

FIG. **6**B is a top view of the tissue implant of FIG. **6**A;

FIG. **7** is a perspective view of an inserter tool for deploying the suture locking system of FIG. **6**A; and

FIGS. **8**A-**8**M depict an exemplary method of using the surgical knot pusher device and suture locking system of FIGS. **5**A and **5**B to repair a meniscus tear.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings and particularly to FIG. **1**, a surgical knot pusher device **10** of the present invention is shown. The device **10** includes a handle portion **12** that can comprise a loop **14** for engaging a user's finger. Though handle portion **12** is illustrated with one loop **14**, the handle portion **12** may include more than one loop **14** for engaging a plurality of the user's fingers. Alternatively, the handle portion **12** can comprise a gripping surface instead of loop **14**. It is contemplated that the handle portion **12** can take any form commonly employed in the surgical tool art such as, e.g., a knob or grip.

As illustrated in FIGS. **1** and **2**, extending from the handle portion **12** is an elongate body **16** having a distal tip **18** at a distal end **20** of the elongate body **16**. Distal tip **18** may be curved, or bent, and tapered. For example, the distal tip **18** may extend from the elongate body **16** at an angle in the range of approximately 0° to 35°. In a preferred embodiment shown in detail in FIGS. **3** and **3**A, distal tip **18** extends at an angle in the range of approximately 12° to 18° from the elongate body **16**. In another embodiment, distal tip **18** can extend at an angle in the range of approximately 27° to 33° with respect to elongate body **16**. The bent and tapered distal tip **18** enables a surgeon to maneuver around the curvature of the patient's

anatomy. For example, the bent and tapered distal tip **18** can effectively move around the curves of a bone joint, such as the condyles of the knee joint.

In one embodiment, distal tip **18** begins to bend from the elongate body **16** at about 3.00 inches from the distal end **20** of distal tip **18**. Along a portion of the distal tip **18** is a dimple, or groove **22** located approximately 0.25 inches from the distal end **20** of the elongate body **16**. FIGS. **3** and **3**A show in detail the groove **22** having a contoured surface **24**, the groove **22** being angled with respect to the surface of tip **18**. Groove **22** is situated on the surface of distal tip **18** facing the bend and enables a length of suture extending out of the groove **22** to lie against the elongate body **16** without substantially increasing the overall diameter of the surgical knot pusher device **10**.

Distal tip **18** also includes a central channel **26** that runs from the groove **22** to the distal end **20** of the distal tip **18**. Central channel **26** has a proximal end that is formed by a radiused wall, and channel **26** has a diameter in the range of approximately 0.025 inches, which provides sufficient clearance for a strand of suture to pass therethrough. As shown in FIGS. **4** and **4**A, approximately 0.10 inches from the distal end **20**, the tip **18** tapers from a 0.08 inch outer diameter to a 0.06 inch outer diameter. At this same position, central channel **26** within distal tip **18** begins to flare out to a conical opening **28** having an angle in the range of approximately 41° and a depth in the range of approximately 0.047 inches. The conical opening **28** should be of sufficient shape and dimensions to cover at least 50% of the knot intended to be pushed forward. The distal end **20** of distal tip **18** is blunt so as not to damage tissue when inserted into a patient's body.

Though illustrated with a bent distal tip **18**, surgical knot pusher device **10** can also include a straight distal tip **18** that has no bend. Typically, the overall length of the surgical knot pusher device **10**, including the handle **12**, is in the range of about 7.5 inches, while the elongate body **16** and distal tip **18** together are in the range of about 5.78 inches long. Elongate body **16** can have a diameter in the range of about 0.093 inches. It is understood that all dimensions are merely exemplary and can be modified and altered as deemed appropriate.

Surgical knot pusher device **10** can be formed from a rigid material and can be made of either biocompatible metal or plastic. For example, device **10** may be formed of surgical grade stainless steel, titanium, or titanium alloys. However, it is contemplated that pusher **10** can be formed from a malleable metal or plastic to enable the surgeon to manually adjust the angle of the distal tip **18** as deemed appropriate. Examples of such materials include stainless steel.

Surgical knot pusher device **10** of the present invention can be used with conventional suture locking systems **80** such as shown in FIG. **5** where an outer wall anchor **40** and a tissue implant **50** are positioned on the outer wall **74** and inner wall **72**, respectively, of a tissue surface **70** having a tear **76** or defect. A connecting suture **60** attached to the outer wall anchor **40** and tissue implant **50** is extended across the tear **76**, the anchor **40** acting as a pulley to effect closure of the soft tissue defect **76** when force is applied to the suture **60**. The suture **60** connecting outer wall anchor **40** to tissue implant **50** can be tied with a slip knot for ease in locking the suture **60**.

FIGS. **6**A and **6**B illustrate in detail an example of a suture locking system **80** suitable for use with the device **10** of the present invention. Suture locking system **80** includes an outer wall anchor **90** and an inner wall implant **100**. Outer wall anchor **90** comprises a generally cylindrical base **92** having a semi-circular flange **94** extending therefrom. A hole **96** is provided on flange **94** for attaching a suture. Outer wall anchor can have a total width in the range of about 5.0 mm and a total height in the range of about 2.5 mm. Inner wall implant **100** is shaped like a tophat and comprises a generally cylindrical base **102** having thereon a generally oval top surface **104**. A through-hole **106** extends through the top surface **104** and out the cylindrical base **102** for threading a suture therethrough. Implant **100** has a total height in the range of about 1.0 mm and a width in the range of about 3.0 to 4.5 mm. Through-hole **106** is dimensioned so as to be able to firmly engage a surgical knot.

Suture locking system **80** can be deployed using inserter tool **120** illustrated in FIG. **7**. Inserter tool includes a cannulated needle **122** having a push rod **124** extending therethrough. As shown, a connecting suture **110** connects anchor **90** to implant **100**. The connecting suture **110** can extend into a slip knot as it exits from the through-hole **102** of the implant **100**. A slot **126** on the cannulated needle **122** enables the anchor **90** to be seated within the cannulated needle **122** while the connecting suture **110** extends out of the cannulated needle **122**. Implant **100**, which is connected to connecting suture **110**, can reside outside of the cannulated needle **122** entirely.

FIGS. **8**A-**8**M illustrate generally a method for surgically repairing a standard repairable meniscus tear **206** using the surgical knot pusher device **10** of the present invention in combination with the suture locking system **80** described above. First, the meniscus tear **206** is evaluated and prepared in the usual manner. Then, the suture locking system **80** is preloaded onto an inserter tool **120**. To effect repair of the meniscus tear **206**, cannulated needle **122** of inserter tool **120** containing the outer wall anchor **90** attached by connecting suture **110** to tissue implant **100** is inserted through a standard medial or lateral portal. The needle **122** is passed through the tissue body, or meniscus **200**, and into the pericapsular tissue posteriorly. Care should be taken to aim the needle away from the popliteal fossa and avoid any neurovascular injury during the procedure.

Connecting suture **110** can be tied in a slip knot to attach tissue implant **100** to the outer wall anchor **90**. As shown in FIG. **8**C, cannulated needle **122** is extended through the meniscus tear **206** to the outside wall **204** of the meniscus **200**, whereupon the push rod **124** of inserter tool **120** is actuated and outer wall anchor **90** ejected from the cannulated needle **122** through to the outer wall **204** of the meniscus **200**. Inserter tool **120** is then removed, leaving the anchor **90** against outer wall **204** with suture **110** extending through the meniscus tear **206** as illustrated in FIG. **8**F. The limb of the connecting suture **110** can be pulled to assure capture and fixation of the outer wall anchor **90**.

The free end of connecting suture **110** can then be threaded through conical opening **28** and the central channel **26** of the surgical knot pusher device **10**, exiting out from the channel **26** to groove **22** as shown in FIG. **8**G. Contoured groove **22** enables the surgeon to rest the leg of the connecting suture **60** against the groove **22** and along the length of the elongate body **16** without significantly affecting the overall diameter of the device **10** or encumbering the workspace of the surgeon. In FIG. **8**H, distal tip **18** of device **10** is placed against the slip knot **112** such that about 50% of the knot **62** is surrounded by conical opening **28**. Using gentle pressure while holding the leg of suture **110** taut against the device **10**, the surgeon can initiate a pulling/pushing action to slide the surgical knot pusher device **10** towards the tissue implant **100**, until the slip knot **112** moves down the suture strand **110** and against the tissue implant **100**, as in FIG. **8**I. Slightly more pressure should be applied to pull the connecting suture **110** than is applied to the pusher device **10**. This will prevent the accumulation of slack in the connecting suture **110**, allowing the tissue implant **100** and slip knot **112** to slide smoothly.

The limb of the connecting suture **110** should continue to be pulled to advance the slip knot **112** and the tissue implant **100** down to the inner wall **202** of the meniscus **200**. The tissue implant **100** should be seated snugly, i.e., "dimpled" into the inner wall **202** of the meniscus **200**, and the slip knot **112** abutting the top surface **104** of the implant **100**, as shown in FIG. **8**K. Tension should continue to be applied to the connecting suture **110** with the pusher device **10** until the slip knot **112** is tightened. The slip knot **112** can then be lodged in the through-hole **106** of the tissue implant **100** by applying pressure against the slip knot **112** with the pusher device **10**. With tension on the connecting suture **110**, the outer wall anchor **90** provides support against the outer wall **204**. As the connecting suture **110** tightens, anchor **90** acts as a pulley, enabling the connecting suture **110** to pull the tissue surrounding the meniscus tear **206** together to promote healing of the meniscus **200**.

Typically the knot-engaging tissue implant **100** is formed from a pliable and resilient material having a configuration that enables knot **112** to become lodged therein. By exerting force on the distal tip **18** of device **10**, the surgeon can force the tissue implant **90** into the inner wall **202** of the meniscus **200**. As seen in FIGS. **8**K and **8**L, once the tissue implant **90** is pushed firmly against the inner wall **202** of the meniscus **200**, and the slip knot **112** tightened, the device **10** can be retracted. The connecting suture **110** is then cut with an arthroscopic cutter (not shown) to leave approximately about 2 mm of suture length. As shown in FIG. **8**M, the above procedure can be repeated until the desired amount of sutures is placed across the meniscus tear **206**. Finally, when the procedures are complete, the meniscus **200** is probed to assure a stable repair.

While the present invention is described for use with a slip knot, it is contemplated that the pusher **10** can be utilized with any type of surgical knot. Further, the pusher **10** can be effective in surgical procedures other than tissue repairs, the pusher **10** being effective for knot pushing in any surgical procedure requiring suturing.

It will be understood that the foregoing is only illustrative of the principles of the invention, and that various modifications can be made by those skilled in the art without departing from the scope and spirit of the invention. All references cited herein are expressly incorporated by reference in their entirety.

What is claimed is:

1. A surgical knot pusher device, comprising:

a handle portion and an elongate body extending from the handle portion, the elongate body having a tapered distal tip, the distal tip having a groove formed in a portion thereof and having a radially enclosed central channel extending long a longitudinal axis of the distal tip from the groove to a distal end of the distal tip,

wherein the central channel is formed by a radiused wall at a proximal end thereof and a section in the shape of a cone at a distal end thereof with a depth that is about twice a diameter of the central channel such that the section in the shape of a cone is sized to protect a prepared knot on a leg of suture to allow it to be pushed down the leg of the suture without deforming or collapsing the knot.

2. The device of claim **1**, wherein the handle portion further includes at least one finger engaging loop.

3. The device of claim **1**, wherein the distal tip extends from the elongate body at an angle of up to approximately 35°.

4. The device of claim **1**, wherein the groove is formed proximally of the distal end of the distal tip.

5. The device of claim **1**, wherein the channel is substantially centrally disposed within the distal tip.

6. The device of claim **5**, wherein the section in the shape of a cone of the central channel comprises a flared conical opening near the distal end of the distal tip.

7. The device of claim **1**, wherein the groove has a contoured surface adapted for seating a portion of the suture.

8. The device of claim **1**, further being formed from a rigid metal or plastic.

9. The device of claim **1**, further being formed from a malleable metal or plastic.

10. The device of claim **1**, wherein the section in the shape of a cone has a taper angle of approximately 41 degrees.

11. The device of claim **1**, wherein the section in the shape of a cone has a depth of approximately 0.047 inches.

12. The device of claim **1**, wherein the distal tip is bent with respect to the elongate body at an angle of approximately 12 degrees to approximately 35 degrees.

13. The device of claim **1**, wherein a proximal surface of the groove is oriented at an angle with respect to the channel of approximately 27 degrees to approximately 33 degrees.

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